at all, their existence may even be denied. On the contrary, when describing complex behaviour when impulses from external or internal stimuli modify each other before the final result is translated into action, it is the intervening physico-chemical processes which are unknown and perhaps ignored, and the action is said to be voluntary or prompted by emotion or the will.

The point I wish to make, however, is that the actions and behaviour of organisms are responses, are characters in the sense described in the earlier part of this address. They are inherited, they vary, they are selected, and evolve like other characters. The distinction so often drawn by psychologists between instinctive behaviour said to be inherited and intelligent behaviour said to be acquired is as misleading and as little justified in this case as in that of structural characters. Time will not allow me to develop this point of view, but I will only mention that instinctive behaviour is carried out by a mechanism developed under the influence of stimuli, chiefly internal, which are constantly present in the normal environmental conditions, while intelligent behaviour depends on responses called forth by stimuli which may or may not be present. Hence, the former is, but the latter may or may not be inherited. As in other cases, the distinction lies in the factors and conditions which produce the results. Instinctive and intelligent behaviour are usually, perhaps always, combined, and one is not more primitive or lower than the other.

It would be a mistake to think that these problems concerning factors and environment, heredity and evolution, are merely matters of academic interest. Knowledge is power, and in the long run it is always the most abstruse researches that yield the most practical results. Already, in the effort to keep up and increase our supply of food, in the constant fight against disease, in education, and in the progress of civilisation generally, we are beginning to appreciate the value of knowledge pursued for its own sake. Could we acquire the power to control and alter at will the factors of inheritance in domesticated animals and plants, and even in man himself, such vast results might be achieved that the past triumphs of the science would fade into insignificance.

Mount Everest.

By LIEUT.-COL. H. H. GODWIN-AUSTEN, F.R.S.

IN the issue of NATURE of March 31 last, p. 137, I offered some remarks on the Mount Everest Expedition. I have now been asked to give some account of the progress made by the recent expedition, and to point out some facts of interest to men of science. I have some hesitation in doing this, as so much has been written by able officers, such as Brig.-Gen. the Hon. C. G. Bruce (*Geographical Journal*, January, 1921) and Major H. T. Morshead (Survey of India, March, 1921), who have done more and been at greater heights than myself.

The news which has come regularly and rapidly through the *Times* reports tells of signal success; fine work has been done, and a difficult task faced with all the enthusiasm such an expedition can create. Enthusiasm for mountain reconnaissance was displayed on the lamentable death of Dr. A. M. Kellas on June 5 at Kampa Dzong, one of the first to join the expedition; in truth, he was already worn out by previous exposure. He gave his life, but not before his knowledge of Himalayan travel and what the native porter can do must have been of inestimable value. Now the expedition has completed its first season's work with the object of reaching next year a point as high as possible on its flank, I can better attempt to show what there is of interest not generally known, what the great height of Everest indicates, and how much it is bound up with the physical features of a vast area and with the geology of the same. There is something more than Mount Everest being the highest peak in the world which is bringing it rather suddenly into notice and proving of interest to the general public. This something I hope to bring before the reader and increase his interest.

I am envious of the good fortune of those who may stand on the flank of Mount Everest. They will, indeed, be fortunate men, for, with a clear horizon, they will look over the world laid out before them; still more fortunate they will be if they can ponder on the many problems it presents. Would that we could recall Sir Joseph Hooker with his knowledge and power of observation. We must not forget what he accomplished with limited means—his mapping and botanical record; indeed, few books of travel are on a level with his "Himalayan Journals."

I would ask the reader first of all to look at a good map of India, noting particularly the scale of miles to an inch on which it is compiled. First, I would direct attention to the peak's association with a gigantic geodetical undertaking, the measurement of an arc of the meridian or the great arc series of triangulation which, starting at Cape Comorin, was carried for 1500 miles to Banog at the base of the Himalaya—systematic work too technical to explain here. It was the conception of Col. Sir George Everest, R.E., when Surveyor General of India, assisted by his successor, Col. Sir Andrew Waugh, R.E. Exact triangulation gives us the true latitude, longitude, and height of the many lofty peaks on the far-off Himalayan chain, with the names and position of which the public are becoming familiar. Among them Everest is the culminating point, 29,202 ft. above sea-level. The great geodesist, George Everest, introduced compensation bars in the measurement of base lines, and measured many with marvellous exactitude; he perfected instruments and produced a theodolite with a circle of 36 in. diameter; he invented also the heliotrope to supersede the pole when observing angles. The Survey of India owes everything to his creative genius, and Mount Everest is the finest monument to his memory. More than this, the survey now in progress in Thibet under Col. D. Ryder, R.E., the present Surveyor General of India, is extending the triangulation to the north, so that of the great arc may follow and be continued many miles further. Pendulum observations will also be feasible, and all will combine to give us a greater knowledge of the figure of the earth's crust and of those irregularities which cause the deviation of the plumb line from its normal direction.

Mount Everest, in common with all lofty points, looks over many thousand square miles of the earth's surface, which has seen enormous changes with which the height of the mountain itself is closely connected. For instance, the Garo Hills are seen from it, 250 miles distant on the south-east. They mark the western extremity of the Assam Range, one which is geologically recent and of elevation corresponding with that of the Sivaliks in Nepal which Everest overlooks. The view will embrace the great deltas of the Ganges and Brahmaputra; the courses of the main rivers will be followed by their wide, sandy beds as they issue from the mountains and flow to the sea, displayed as on a map—and what a changing map it has been—how affected by seismic action—a map of absorbing interest. Mount Everest is close upon the southern face or scarp of what may be termed an ancient plateau of denudation, well shown in Photograph 5 reproduced in the *Geographical Journal* for October, which depicts what we see at the present day, a surface configuration after thousands of years of wear and tear The high plateau type of country of great elevation, none of it below 14,000 ft., can be said to commence in Rupshu, is continued on the Pangkong Lake, and widens out rapidly in Rudok. It is fairly well populated by a hardy race having many good qualities; crops are raised with difficulty, but enormous flocks and herds are reared. Denudation began with the very earliest Sivalik deposits, and continued until a quite recent Glacial period, one of extreme conditions. Even here, in latitude 28°, the glaciers were of great extent, though nothing compared with the lengths they attained in the north-west Himalaya when the Indus valley at Skardo was filled with ice and moraines, and even in the valley of Kashmir, latitude 34°, the Sind valley glacier extended to the valley itself not far from Srinagar, and was some forty miles long. Although hundreds of travellers pass up and down this beautiful valley, how very few of them know of this, yet the rocks, ground by the ice and striated by the stones which were embedded in it, are clearly to be seen.

During the Glacial period a great ice cap covered all the country here; and the work it performed is shown in the rounded outline of the spurs given off from Mount Everest.

In the letter of October 2 from Kharta, published in the *Times* of October 21, we have the first record of the geological structure of the Everest mass. It is short but worthy of notice. Col. Howard Bury says: "Immediately to our left towered up Makalu's great cliffs of white granite, so steep as to be snow free; it is a most imposing and marvellous mountain, looking incredibly thin, so perpendicular are its sides." Is this granite intrusive? Judging by analogy, it is. What Everest is composed of we have yet to learn. We have some data to guide us in Sir Joseph Hooker's diary of the Tambar valley at its southern end, where, on the Pemmi River, at about 2260 ft., he recorded ("Himalayan Journals," vol. 1, p. 192, 1854): "The rocks above 5000 feet were gneiss; below this cliffs of very micaceous schists were met with, having a north-west strike and being often vertical; the boulders again were always of gneiss." This strike (the prevailing one in this area) would extend towards Everest, and indicates what may be expected there.

The valley of Nepal came into existence with the great movements in late Tertiary times, when the Sivaliks were compressed and elevated on a belt of 1500 miles. A roll in the strata formed the Dun through which the waters of the Kosi and Gandak, keeping pace with the elevation, slowly cut their exit to flow into the ancient depression of the Bay of Bengal. The Nepal valley is therefore, in its physical features, similar to that of Assam on a very much smaller scale; that of the Deyra Dun is on a still smaller one. Looking to the Sikkim side, situated only fifteen miles from the plains, and towering above them, is the conspicuous point Gyepmochi, 14,418 ft. high. I know it well; it is of intrusive granite. It is connected with Kangchenjunga by the high, parting range, crossed at the Jalap La. Chamalarhi, 23,930 ft., which is seen from this direction on the north, has been said to be of an intrusive rock.

Going back to the Glacial period, it is worthy of notice, as not generally known, that from Gyepmochi deposits of morainic type extend to the plain of the Bhutan Dooars. A stream of large blocks of granite (one 10 ft. long) can be followed for eight miles, and is a conspicuous feature. A similar extension of ice action may be looked for south of Mount Everest, but not at so low a level, in the Nepal valley.

The next main valley beyond Gyepmochi, having its sources in Thibet, is the Am-mochu. The scarp lies south of Chumbi, as is shown in the steep fall in the bed of the river to Tsangbe. As it nears the plains it flows directly on to them; there is no Dun, but a massive limestone of unknown age brought up by a great fault occurs at

Balla, and thence, by the name of the Bura Torsa in the plains, the stream goes to join the Brahmaputra opposite the Garo Hills. Curiously enough, the Sivalik or Tertiary formation is absent at Balla, but it may be hidden beneath the recent alluvium. For twenty-five miles it is not visible, but at Buxar the Sivaliks suddenly reappear in considerable thickness, and contain abundant fossilised boughs of trees, indicating a forest-clad country on the north when they were laid down. These sandstones continue without a break and with varying breadth to far-distant Eastern Assam at the base of the Abor Hills.

To see the Tertiaries again as exemplifying the extent of Himalayan denudation one has to cross the broad alluvial valley of the Brahmaputra some 100 miles south, where they lie up against the Assam Range and contiguous to the intrusive granite there. They can be followed to Sylhet, to Jaintia, and the Naga Hills, rising in altitude until they reach in the latter country a height of 10,000 ft., the whole thickness being exposed from base upwards. The geological evidence goes to show that this late elevation of the Assam Range diverted the direct courses of the Subansiri and Tsanspu of Thibet which originally flowed through Burma to the sea into the present less direct route into the Bay of Bengal, and completely altered the ancient geography, and particularly the features of the Gangetic Delta.

I have mentioned granite intrusion. This leads me to refer to a very recent contribution in the Journal of the Geographical Society, September, 1921, p. 199, by Col. Sir Sydney Burrard, "On the Origin of Mountain Ranges." He asks: "Have they been elevated by horizontal compression of the surface, or by vertical uplift from below?" Further on: "It is difficult to be satisfied with the theory that mountains have arisen from horizontal compression, and we have to face the question: What is the force that has raised mountains?" (in this case the Himalaya). Again, on p. 200: "The highest summits are generally composed of granite, and the granite masses are believed to have risen out of the crust." I follow and agree with him, adding that actual observation is better than the many theories that have been put forward, such as that of Col. E. A. Tandy, R.E., "that falling stones sink by their own weight into the crust as though the latter were molten."

In Baltistan I was first struck by the evidence that the granite was intrusive, and I had the support of Gen. McMahon (*Geological Magazine*, 1897, p. 304), and discussed it with him. I came to the conclusion that granite intrusion has done more to elevate the Himalayas than any other force. It penetrates the metamorphic rocks, and has carried them up with it, and it can be followed for an enormous distance on the outer face of the great range, though always in the same relative zone.

In Nepal we have no data to go by, but at the Kali River, in longitude 80°, the granite—evidently intrusive—mapped by Capt. Herbert in 1815, after the Nepal War, is a conspicuous feature at Nynee Tal. The well-known Chor Peak near Simla extends it, while at Dharmsala is the most remarkable out-pouring forming the Dhauladhar, where, as the late Gen. C. A. McMahon points out, it is twelve miles broad. The Chatadhar extension, where I have seen and mapped it myself, is seven miles broad—where it has carried up the Nummulitic formation to the crest of the range—and in its plastic-looking state appears to lie above the Eocene and Pleistocene formations, compressing them and turning them over to a high, reversed dip. With such breadths of intrusion we have not far to go to find a cause for the folding and faulting of the Sivaliks rocks. In Kashmir similar granite intrusion is met with on the Pir Panjal and on the Kajnag Range west of Baramulla, up to Mozufferabad, with inversion of the Eocene on the south.

In the *Times* report of October 21 are the truly sensational headlines, "Wild Hairy Men," "Human Footprints." I fear the missing link has not yet been found; nevertheless, the observation has interest, and can be explained by the fact that a large species of monkey, probably of the genus Semnopithecus, the Hannman, or Lungur, has found its way from the Nepal side into Thibet, and has been reported to extend north of the Tsanspu. The late Capt. C. G. Rawling, R.E., in his excellent book, "The Great Plateau" (pp. 222, 223), tells how Capt. H. Wood, R.E., saw a troop of monkeys in November at Sangsang, which is nearly due north of Mount Everest; unfortunately, it was too late in the day to follow them and secure a specimen. These animals live there all the year round—a very interesting fact—and to be visible at 500 yards it must be a large species. Even on the slopes of Everest this monkey, which is omnivorous, would find plenty to live on, for the hare found everywhere in this region is abundant and easily caught in its forme after a cold night. A Lungur could in a few hours be down in warmth on the Nepal side, and in all probability the footprints were those of one retiring before the advent of the expedition camp. Mr. Briant H. Hodgson, who was for so many years resident at Katmandoo, brought together a splendid collection of mammals and birds, and he is not likely to have missed the existence of a new monkey in the valley of Nepal. I find that in August, 1834, he exhibited his extensive series of skins of mammalia at a meeting of the Zoological Society of London. An abstract of the species shown is given (Proc. Zool. Soc., p. 95, 1834), and it is stated that *Semnopithecus entellus* of F. Cuvier "has been introduced by religion into the central district (*i.e.* of Nepal), where it flourishes, half-domesticated, in the neighbourhood of temples." What more likely than that it has met the same happy protection in Thibet, the only part of the world where all living creatures can live in peace?